PROPOSED FRAMEWORK FOR MANAGING ACID SULFATE SOILS

Department of Environment

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Prepared by
Environmental Management Division
Department of Environment

DEPARTMENT OF ENVIRONMENT
JUNE 2004 REPORT BASED ON OUTCOMES
OF ACID SULFATE SOILS WORKSHOP, JUNE 2003

Acknowledgments

This document has been prepared by Land and Water Quality Branch staff within the Environmental Management Division, Department of Environment and is based on the outcomes of the Acid Sulfate Soils Workshop held at Curtin University on 12-13 June 2003. The workshop involved community representatives, catchment co-ordinators, industries, state and local government agencies, and national and state experts in Acid Sulfate Soils. These outcomes were summarised by a focus-group consisting of Dr Steve Appleyard (Department of Environment), Mr Stephen Wong (Department of Environment), Bernie Powell (Department of Natural Resources and Mines, Qld), Col Ahern (Department of Natural Resources and Mines, Qld), Mr John Williams (Chairman, National Committee for Acid Sulfate Soils, NSW Agriculture), Prof. Ian White (Australian National University, Canberra), Dr Jes Summut (University of NSW) and Dr Rob Fitzpatrick (CSIRO Land and Water, Adelaide) with the assistance of the WA Acid Sulfate Soil Working Group.

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How to make a submission:

The Department of Environment (DoE) has determined that this document should be available for public comment commencing on Thursday 3 June 2004. The closing date for submissions is Tuesday 31 August 2004.

For the DoE to consider submissions on the proposed acid sulfate soils management framework in WA, comments should be received before the above closing date.

Submissions are preferred in electronic format, if possible, and can be e-mailed to:
steve.appleyard@environment.wa.gov.au *or* stephen.wong@environment.wa.gov.au *Otherwise please address to:*
The Department of Environment, Level 8, 141 St Georges Terrace, Perth WA 6000.
Attention: Steve Appleyard or Stephen Wong.

All submissions received by the DoE will be acknowledged. Electronic submissions will be acknowledged electronically. Submissions may be fully or partially utilised in compiling a summary of the issues discussed in the proposed management framework. All submissions will be treated as publicly available unless marked confidential.

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Contents

Executive Summary

Acid sulfate soils are naturally occurring soils that contain iron sulfide minerals, predominantly as the mineral pyrite. Acid sulfate soils are most likely to occur in coastal regions of the State, but can also be associated with dryland salinity in some inland agricultural areas.

These soils do not pose a significant risk to human health or the environment when undisturbed. However, the disturbance of these soils and oxidation of pyrite by drainage, dewatering or soil excavation can cause:

- significant environmental and economic impacts including fish kills;
- damage to estuarine fisheries and loss of biodiversity in wetlands and waterways;
- contamination of surface and ground water resources by acids, arsenic, heavy metals and other contaminants;
- loss of agricultural productivity; and
- corrosion of concrete and steel infrastructure by acidic soil and water.

The potential impacts on the State's environment and economy can be significant and require a coordinated framework to manage the issue in a manner consistent with strategies developed in other States and the National Strategy for Managing Acid Sulfate Soils. A workshop of community, catchment group, agency, and national experts in managing Acid Sulfate Soils was held as part of the Acid Sulfate Soils WA Workshop at Curtin University (12-13 June 2003). This workshop proposed that a Western Australian framework should have five key objectives:

1. to identify the distribution and potential severity of acid sulfate soils in the State through risk maps and soil sampling programs;
2. to avoid the disturbance of acid sulfate soils wherever possible through planning controls;
3. to mitigate the effects of disturbing or draining acid sulfate soils by implementing Best Management Practices (BMPs) in areas where development is unavoidable;
4. to rehabilitate areas historically affected by acid sulfate soil disturbance; and
5. to increase awareness of acid sulfate soils, and to implement appropriate training programs in the management of these soils.

To achieve these objectives and facilitate development of a State Framework for Managing Acid Sulfate Soils, the following tasks are recommended for further discussion:

(i) Designate the Department of Environment (DoE) as the lead coordinating agency in the management of acid sulfate soils in Western Australia.

(ii) Establish a Western Australian Acid Sulfate Soil Advisory Committee (WAASSAC) to advise on the implementation of a State management framework. WAASSAC should report directly to the Minister for the Environment on an annual or as needs basis, and the role and functions of the committee should be reviewed after a period of five years.

(iii) Consolidate natural resource data relevant for the compilation of acid sulfate soil risk maps. This would be undertaken by the DoE with advice from WAASSAC. The DoE should also develop and be the custodian of a database of acid sulfate soil chemical data that should be accessible by the public.

(iv) Carry out acid sulfate soil risk mapping for coastal regions in Western Australia. This would be undertaken by the DoE with advice from WAASSAC and the National Committee for Acid Sulfate Soils.

(v) Seek advice from the DoE, CSIRO Land and Water, WAASSAC and the National Committee for Acid Sulfate Soils advise on requirements for incorporating the mapping of inland soils with acid producing potential into the Salinity Action Plan.

(vi) Continue to develop planning measures to prevent the disturbance of acid sulfate soils wherever possible.

(vii) Determine the extent to which wetlands on the Gnangara and Jandakot Mounds are underlain by acid sulfate soils and ensure that Environmental Water Provisions for those wetlands are adequate to prevent them from becoming acidic. Similar investigations should also be carried out for other wetlands with high environmental values in other parts of the State.

(viii) Develop guidelines for managing the use of domestic garden bores in areas underlain by acid sulfate soils to prevent groundwater acidification and contamination.

(ix) Develop an education program for the public and the drilling industry about the risks of using untreated groundwater as a source of drinking water in areas underlain by acid sulfate soils.

(x) Identify suitable sites for the safe management and disposal of acid sulfate soils and develop a long-term waste disposal strategy for these materials. This task would be undertaken by WAASSAC in consultation with State and local government authorities

(xi) Foster research to develop construction, groundwater and soil management guidelines that are appropriate for use in areas with acid sulfate soils in Western Australia. This task would be undertaken by WAASSAC.

(xii) Identify acid sulfate soil-related problems that require remediation, and select demonstration sites to foster research on remediation techniques appropriate for use in Western Australia. WAASSAC and the DoE would work closely with local government authorities and the community to complete this task.

(xiii) Increase awareness of acid sulfate soils, and coordinates the development of education and training programs on acid sulfate soil issues in Western Australia.

(xiv) Develop and assist the accreditation of appropriate TAFE or other professional development courses for identifying, assessing and managing acid sulfate soils in Western Australia.

(xv) Incorporate information on acid sulfate soils into existing undergraduate courses, and through CSIRO, universities and State agencies consider commissioning, funding and fostering specific research on acid sulfate soil issues.

1 Background

Acid sulfate soils are naturally occurring soils that contain iron sulfide minerals, predominantly as the mineral pyrite. Acid sulfate soils are most likely to occur in coastal regions of the State, but can also be locally associated with dryland salinity.

These soils are generally benign when undisturbed, but the exposure of pyrite to air by the drainage, dewatering or excavation of soil can generate substantial amounts of sulfuric acid. Drainage water in contact with the oxidising soil usually becomes acidic and leaches substantial amounts of metals from the soil. The discharge of acidic water into waterways and wetlands may cause fish kills and loss of aquatic biodiversity, and the infiltration of water through the soil profile may contaminate groundwater with acid, arsenic, metals and other contaminants.

The watertable on both the Gnangara and Jandakot Mounds has been progressively declining due to a long period of below-average rainfall and increased groundwater abstraction, and there is a risk of a large number of wetlands becoming acidic.

The acidification of surface water bodies commonly increases mosquito breeding, as mosquito larvae are generally more resistant to acidic conditions than their predators. This in turn could lead to increases in mosquito-borne diseases such as Ross River virus if expensive mosquito-control measures such as frequent spraying of pesticides or runnelling are not implemented at these water bodies.

Acidic drainage may also reduce agricultural productivity and corrode urban infrastructure such as underground pipes and concrete foundations. It is estimated that there are more than two million hectares of acid sulfate soils throughout Australia (NatCASS, 2000), which could cause more than $10 billion worth of damage if these soils were all disturbed. About 30% of Australia's acid sulfate soils are thought to occur in Western Australia.

1.1 Management needs

The disturbance of acid sulfate soils by poorly planned and managed development has caused severe environmental problems in many regions of Australia, and consequently most States have developed coordinated strategies to manage these issues. Western Australia is the only State that has yet to develop a State acid sulfate management framework, largely because acid sulfate soils were not considered to have caused significant environmental problems in Western Australia until recently.

It is likely that Western Australia has not suffered from major environmental problems caused by the disturbance of acid sulfate soils until recently due to the relatively low population of the State and the fact that most development until recently has taken place in sandy areas where there was little occurrence of these soils. However, development pressure is increasing in low-lying swampy areas due to increasing land values, particularly in wetland areas near major urban centres in the State and in foreshore areas of major estuaries such as the Swan-Canning estuaries and the Peel-Harvey and Leschenault Inlets. This development pressure will increase the risk of acid sulfate soil related environmental problems occurring unless the disturbance of these soils is carefully managed.

The significance of acid sulfate soils in Western Australia became apparent in January 2002 with the discovery of widespread groundwater acidity problems and contamination by arsenic caused by the disturbance of sulfide-rich peat soils for urban development. Additionally, some wetlands in areas protected for public water supply on the Gnangara Mound were showing signs of acidification. Since 2002, acid sulfate soils have been discovered in areas fringing the Swan-Canning Estuary (particularly on the foreshore area of the Perth CBD); near the Peel-Harvey and Leschenault Inlets and near Albany. It is likely that problems caused by the disturbance of acid sulfate soils will continue to be detected as awareness of these soils increases in the State.

In a report summarising groundwater investigations in Stirling (Water and Rivers Commission Report, 2002), the former Water and Rivers Commission recommended that the State government implement measures outlined in the National Acid Sulfate Soil Strategy to ensure that there was a coordinated approach to managing this issue in Western Australia.

Following the discovery of problems caused by acid sulfate soils in Stirling, the Department of Environment (DoE) established an informal acid sulfate working group with stakeholders from relevant government agencies, industry and the community to coordinate the management of acid sulfate soils. Although this group had no statutory authority, it oversaw the development of a Guidance Note produced by the Environmental Protection Authority (EPA)/DoE to provide general information to the community on acid sulfate soils in the State, and a series of guideline documents to assist a variety of stakeholders to assess and manage acid sulfate soils. The working group also helped organise the inaugural Acid Sulfate Soil Workshop for Western Australia which was held in June 2003. Community groups, catchment groups, state agencies and national experts in Acid Sulfate Soils agreed on key management needs for Acid Sulfate Soils in WA. The recommendations from the workshop form the basis for this proposed framework for managing acid sulfate soils.

2 Proposed State Management Framework

The proposed framework for managing acid sulfate soils is based on five key objectives and on establishing the institutional arrangements to allow programs to be implemented to target the objectives. The key objectives in the management framework are:

1 to identify the distribution and potential severity of acid sulfate soils in the State through risk maps and soil sampling programs;

2 to avoid the disturbance of acid sulfate soils wherever possible through planning controls;

3 to mitigate the effects of disturbing or draining acid sulfate soils by implementing Best Management Practices (BMPs) in areas where development is unavoidable;

4 to rehabilitate areas historically affected by acid sulfate soil disturbance; and

5 to increase awareness of acid sulfate soils, and to implement appropriate training programs in the management of these soils.

2.1 Institutional arrangements

Management of acid sulfate soils in Western Australia requires a coordinated "whole of government" approach by State government agencies with active community and local government participation in the management of these soils through an advisory committee appointed by State government.

A lead agency is required to ensure that there is a coordinated approach by State government agencies. In most other states, acid sulfate soil problems occur predominantly in rural areas so that the coordination role is taken by agricultural or natural resource management agencies. However, in Western Australia soil acidification has occurred in both urban and rural areas, and it is also likely groundwater resources could be affected by contamination from the disturbance of acid sulfate soils. It is therefore considered appropriate that the DoE be the lead agency in Western Australia. The DoE has considerable expertise in identifying and managing these soils, and has the legislative authority through the Environmental Protection Act 1986 and the *Contaminated Sites Act 2003* to regulate the disturbance of acid sulfate soils. In addition the DoE provides technical support for the implementation of the State Planning Bulletin 64 that provide advice and guideance on matters in the rezoning, subdivision and development of land that contains acid sulfate soils. Currently, the DoE is a member of the National Committee for Acid Sulfate Soils, the Committee responsible for implementing the National Strategy.

Recommendation 1.

The Department of Environment has a leading role coordinating the management of acid sulfate soils in Western Australia.

In other states, the community participates in the management of acid sulfate soil issues through a formal advisory committee, appointed by the relevant Minister, and which reports directly to the Minister. Membership of the advisory committee generally comprises a range of stakeholders from the community, industry groups and government agencies who are potentially affected by acid sulfate soil issues including those who can influence decision makers in planning and land management of areas underlain by acid sulfate soils. The advisory committees oversee the implementation of state strategies.

Recommendation 2.

Establish a Western Australian Acid Sulfate Soil Advisory Committee (WAASSAC) to advise on the implementation of a State management framework. WAASSAC should report directly to the Minister for the Environment on an annual or as needs basis, and the role and functions of the committee should be reviewed after a period of five years.

2.2 Objectives of the management framework

2.2.1 Identify the distribution of acid sulfate soils in WA

Understanding the distribution and severity of acid sulfate soils is a prerequisite for managing environmental problems caused by the disturbance of these soils in the State. Despite the fact that the first recorded occurrences of acid sulfate soils in Australia were in Western Australia (Woodward, 1917; Teakle and Southern, 1937), there is currently a very poor understanding of the distribution of these soils in the State as this issue has not been taken into consideration during the compilation of natural resource inventories.

Although there is a large amount of geological, soil and vegetation information that can help identify the distribution of acid sulfate soils, the relevant data are scattered across a large number of agencies, and there are only a very limited number of soil chemical analyses that can confirm the presence of acid sulfate soils in the State. These data need to be identified and consolidated to assist the compilation of comprehensive acid sulfate soil risk maps. Additionally, since the implementation of site assessment guidelines, acid sulfate soil chemical data are now being provided by developers to the DoE to be captured in a database to assist with acid sulfate soil mapping programs. These data should also be accessible by the public to assist with land and water resource management in critical areas.

Recommendation 3

The Department of Environment, with advice from WAASSAC, consolidates natural resource data relevant for the compilation of acid sulfate soil risk maps. The Department of Environment should also develop and be the custodian of a database of acid sulfate soil chemical data that will be accessible by the public.

The DoE has compiled a preliminary acid sulfate soil risk map for the Swan Coastal Plain between Gingin and Busselton, a region where there is currently intense development pressure in the State. The map has been compiled using existing geological information and is useful for giving preliminary guidance for identifying areas where there is likely to be a high risk of acid sulfate soils occurring.

However, little or no soil chemical data currently exist to test the validity of the preliminary map or the map boundaries. Additional field investigations are required to provide more certainty about the distribution of acid sulfate soils in critical areas on the Swan Coastal Plain, and to extend the acid sulfate soil risk mapping to other coastal regions of the State. The State government has allocated $650,000 over the 2003/04 and 2004/05 financial years for the DoE to undertake soil sampling and more detailed mapping of acid sulfate soils in areas of intense development pressure.

Other mainland Australian States have already carried out acid sulfate soil mapping programs in coastal regions, and consequently Western Australia has the opportunity to utilise expertise gained in other States, and to learn from the successes and failures of these mapping programs. At this stage, it is proposed to carry out the regional mapping using the soil-transect sampling approach adopted in South Australia as this is considered to be the most cost-effective method of providing broad risk maps coverage for coastal regions of south-west Western Australia with the available funding.

It is likely that more detailed mapping will be required in specific regions with intense development pressure such as the Perth metropolitan and Peel regions and broad coverage in areas along the south, central and northern coastlines. In high development areas, it is likely that the Queensland approach of drilling and sampling soil cores on a grid of one core per square kilometre will be adopted. This approach will give greater certainty about the extent and severity of acid sulfate soils to planners and developers in critical areas. WAASSAC will have a key role in working with community groups and local governments to identify detailed mapping priorities and to help secure funding to undertake this work.

This acid sulfate soil mapping approach for coastal regions in Western Australia should be reviewed by WAASSAC with advice from the National Committee for Acid Sulfate Soils to ensure that the mapping will provide adequate information about the extent and severity of these soils.

Recommendation 4

The Department of Environment carries out acid sulfate soil risk mapping for coastal regions in Western Australia with advice from WAASSAC and the National Committee for acid sulfate soils.

Soils with the potential to produce sulfuric acid also occur in some agricultural areas in Western Australia associated with dryland salinity. Acidic springs and seeps with pyrite have been identified at Westdale, Wooroloo, and near Brookton, Bindoon and Capel. These soils are referred to as "inland acid sulfate soils" (Fitzpatrick et al, 2001) and can be found in some parts of the wheatbelt. They may represent a significant problem for remedial actions in landscape affected by salinity. For example a proposal to drain salinity affected land by deep drainage to lower the watertable may conflict with the acid sulfate soils management objectives of ensuring that the watertable is maintained at a suitable level to prevent the oxidation of sulfides to the air.

CSIRO Land and Water are currently developing landscape models to predict the occurrence of inland acid sulfate soils, and these models will assist the mapping of the distribution of these soils. Inland acid sulfate soils are closely associated with occurrences of dryland salinity, and so it is considered appropriate that mapping the distribution of these soils is incorporated into the State Salinity Action Plan.

Recommendation 5

The Department of Environment, CSIRO Land and Water, WAASSAC and the National Committee for Acid Sulfate Soils advise on requirements for incorporating the mapping of inland soils with acid producing potential into the Salinity Action Plan.

2.2.2 Avoid the disturbance of acid sulfate soils

Acid sulfate soils are generally benign if they are left undisturbed and if pyritic material is not exposed to air by lowering the watertable by drainage or dewatering. Consequently, avoiding disturbance through effective planning and land management measures is the most effective way of preventing environmental problems in areas underlain by these soils.

The Western Australian Planning Commission has recently released Planning Bulletin 64 - Acid Sulfate Soils. This document was achieved through close collaboration between the Department for Planning and Infrastructure and the DoE. The Planning Bulletin is linked with the preliminary acid sulfate soil risk map, and will indicate the extent that new development proposals will need to be assessed for the presence of acid sulfate soils. This planning measure will flag the issue of acid sulfate soils early in the development process and will ensure proposals in critical areas are referred to the DoE for advice and guidance. Additional planning controls may be required as further information becomes available about the distribution of acid sulfate soils in Western Australia.

Recommendation 6

Continue to develop planning measures to prevent the disturbance of acid sulfate soils wherever possible.

Pyrite-rich peaty sediments often underlie groundwater-dependent wetlands on the Swan Coastal Plain. These wetlands are susceptible to acidification if the watertable falls below the pyritic material, and this can cause major changes in the ecology of the wetlands, particularly for macro- invertebrate communities (Sommer and Horwitz, 2001).

Depending on the extent to which the watertable declines and the degree of disturbance of the lake beds, the acidification may be reversible. However, in some cases long-term and possibly permanent acidification takes place which greatly reduces the biodiversity and ecological value of the wetland. Lake Gnangara is an example of this, as this wetland has been acidic since the lake bed was disturbed by mining in the 1970s.

The watertable on both the Gnangara and Jandakot Mounds has been progressively declining due to a long period of below-average rainfall and increased groundwater abstraction, and there is a risk of a large number of wetlands becoming acidic if this is not managed. Currently, very little is known about the extent to which wetlands on the Jandakot and Gnangara Mounds are underlain by acid sulfate soils, and about the depth at which pyrite occurs. This needs to be determined as a matter of urgency and Environmental Water Provisions (EWPs) for the wetlands adjusted to protect the environmental values of the wetlands. In some cases, this may mean reducing groundwater abstraction near wetlands to maintain the watertable above pyrite layers, or pumping groundwater into wetlands to prevent the pyrite from oxidising.

Recommendation 7

Determine the extent to which wetlands on the Gnangara and Jandakot Mounds are underlain by acid sulfate soils and ensures that Environmental Water Provisions for those wetlands are adequate to prevent them from becoming acidic. Similar investigations should also be carried out for other wetlands with high environmental values in other parts of the State.

Groundwater investigations in the Perth suburb of Stirling indicated that the oxidation of sulphide rich peat caused by dewatering and peat excavation resulted in the release of large amounts of metals particularly aluminium and iron, but also heavy metals such as lead and arsenic into groundwater. Concentrations of arsenic of up to 800 (*u*g/L were detected in domestic garden bores, and up to 7000 (*u*g/L in drilled boreholes. The national drinking water guideline for arsenic is 7 (*u*g/L (NHMRC, 1996).

High arsenic concentrations in groundwater pose a health risk for domestic garden bore users. Although residents had been advised not to drink water from garden bores there are other possible routes of exposure to this toxic element including ingesting home-grown fruits and vegetables irrigated with contaminated groundwater; filling swimming pools, and children playing under garden sprinklers.

Currently, there are more than 135 000 garden bores in the Perth Metropolitan Region, which are largely unregulated. Although the DoE regulates groundwater abstraction from large irrigation bores and dewatering operations through permitting, there is no mechanism in place to manage garden bore users in areas underlain by acid sulfate soils. These areas are susceptible to groundwater acidification and arsenic contamination from excessive groundwater abstraction, particularly during periods of below-average rainfall.

Recommendation 8

Develop guidelines for managing the use of domestic garden bores in areas underlain by acid sulfate soils to prevent groundwater acidification and contamination.

Many households in regions outside of the Perth metropolitan area rely on groundwater for domestic supply and as a source of drinking water, despite advice from the Department of Health and the DoE that untreated groundwater is unsuitable for drinking. The Department of Health and WAASSAC need to continue to advise these residents and the drilling industry about the possible risks of drinking groundwater in areas underlain by acid sulfate soils, and to recommend that these groundwater users regularly test their bores for acidity, arsenic and heavy metals.

Recommendation 9

Develop an education program for the public and the drilling industry about the risks of using untreated groundwater as a source of drinking water in areas underlain by acid sulfate soils.

2.2.3 Mitigate the effects of acid sulfate soil disturbance

Where disturbance of acid sulfate soils is unavoidable, dewatering, drainage and soil excavation needs to be carried out according to best management practices (BMPs) to minimise the risk of groundwater acidification and contamination, and to minimise environmental impacts on nearby wetlands and waterways. This involves:

- ensuring that the extent and severity of acid sulfate soils beneath a site are fully characterised by appropriate site investigations;
- ensuring that dewatering is carried out in a staged manner to minimise excessive oxidation of pyrite; and
- ensuring that the excavation, management and disposal of acid sulfate soil is carried out in an appropriate manner to either prevent pyrite oxidation, or fully neutralise the total acidity generated by pyrite oxidation.

The long-term storage or disposal of excavated acid sulfate soils is becoming a significant issue in the Perth region. More urban development projects are encountering these soils, and similar problems are likely to emerge elsewhere in the State. Although some acid sulfate soils are suitable for reuse after neutralisation with lime or in soil-blending mixtures, some alluvial and clayey soils are unsuitable for reuse and would require disposal to a suitable site. Current management options include strategic reburial at disused limestone quarries where there is sufficient neutralisation capacity to treat acid sulfate soils or reburial in water. Recent investigations have revealed that inappropriate disposal and stockpiling of acid sulfate soils can cause significant long term environmental and health impacts. A long-term management framework is required to deal with the expected increase in demand for disposal.

Recommendation 10

WAASAC in consultation with the state and local government authorities identify suitable sites for the safe management and disposal of acid sulfate soils and develop a long-term waste disposal strategy for these materials.

The Queensland Acid Sulfate Investigation Team (QASSIT) at the Queensland Department of Natural Resources has been developing methods for managing the disturbance of acid sulfate soils over the last decade. QASSIT has developed a number of investigation and soil management guidelines which are considered to be best management practices. As an interim measure, these guidelines have been adopted by the DoE in Western Australia in order to manage soil disturbance in areas with acid sulfate soils.

Although the Queensland guidelines are generally applicable in Western Australia, they do not consider some issues such as best management practices for dewatering or for handling sulfide-rich peat that are common in Western Australia but rarely occur elsewhere in Australia. Additional research is required to develop guidelines to manage these issues, and to modify other Queensland guidelines for local conditions. Research is also required into alternative construction techniques that do not require the removal of acid sulfate soils (particularly for peaty soils) which is currently a standard practice in Western Australia.

Recommendation 11

WAASSAC fosters research to develop construction, groundwater and soil management guidelines that are appropriate for use in areas with acid sulfate soils in Western Australia.

2.2.4 Rehabilitate disturbed acid sulfate soils and acidic drainage

Given the current low level of awareness about acid sulfate soil issues in Western Australia, it is likely that some vulnerable areas have already been disturbed and are causing environmental problems that have yet to be recognised. Acid scald landscapes with little or no vegetation growth caused by progressive soil acidity, particularly along the Peel Estuary caused by maintenance dredging programs have created secondary acid sulfate soil formation along the foreshore. It is estimated that more than 3,000,000 m3 of dredged spoils have been deposited along the Peel and Yunderup areas and their potential offsite impacts have yet to be established. Periodic fish kills in some rivers and estuaries may be incorrectly blamed on deoxygenation or algal blooms as the symptoms of fish deaths look similar, and detailed pathology is often required to clearly identify the cause of the kills.

A number of acid sulfate soil-related problems have emerged in Western Australia that are likely to cause environmental and infrastructure damage unless identified and rehabilitated. These issues include:

- acidic dredge spoil adjacent to the Peel-Harvey Estuary;
- acidic groundwater-dependent wetlands in the Perth region; and
- potential for acidification of wetlands due to the practice of runnelling1 in identified acid sulfate soils as a physical control measure for mosquitoes.

The DoE and WAASSAC need to work closely with local government authorities and the community to ensure these issues are managed and ultimately remediated. In some cases, remediation may be possible using methods developed in other parts of Australia, or methods adapted from acid mine drainage remediation technologies. In other cases, solving the acidity problems may be complex and require experimentation and field trials. A number of active demonstration sites are urgently needed to increase awareness of problems caused by the disturbance of acid sulfate soils, and to develop and test remediation techniques that are appropriate for local soils and conditions.

Recommendation 12

WAASSAC and the Department of Environment work closely with local government authorities and the community to identify acid sulfate soil-related problems that require remediation, and to select demonstration sites to foster research on remediation techniques appropriate for use in Western Australia.

2.2.5 Implementation

It will not be possible to fully implement a State management framework without a high level of awareness of acid sulfate soil issues in the community, and without sufficient well-trained people to identify these soils.

The DoE has been preparing pamphlets and running information/training seminars, workshops and media events to raise awareness of acid sulfate soil issues in the community. This work is being carried out by a limited number of staff as part of existing programs. Consequently the awareness programs have limited reach and effectiveness without additional resources to ensure awareness and training programs are appropriate and well targeted.

Recommendation 13

Increase awareness of acid sulfate soils, and coordinates the development of education and training programs on acid sulfate soil issues in Western Australia.

Specific training programs are required to increase the competency of local government authorities and State government agencies to identify, assess and manage problems caused by the disturbance of acid sulfate soils. It is likely that TAFE courses are the most appropriate vehicle for delivering this training. The Queensland Department of Natural Resources is currently developing and accrediting TAFE training on acid sulfate soil issues, and it is possible that these courses could be modified for local conditions and adopted in Western Australia.

Recommendation 14

Develop and assist the accreditation of appropriate TAFE or other professional development courses for identifying, assessing and managing acid sulfate soils in Western Australia.

Western Australia will also need to access specific expertise to remediate acid sulfate soil problems and to develop new methods for rapidly identifying and assessing problems. This expertise needs to be developed within universities and research organisations like CSIRO. Possible avenues for developing this expertise include incorporating information on acid sulfate soils into existing undergraduate courses at universities, and commissioning, funding and fostering specific postgraduate research on these issues.

Recommendation 15

Incorporate information on acid sulfate soils into existing undergraduate courses, and through CSIRO, universities and State agencies consider commissioning, funding and fostering specific research on acid sulfate soil issues.

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